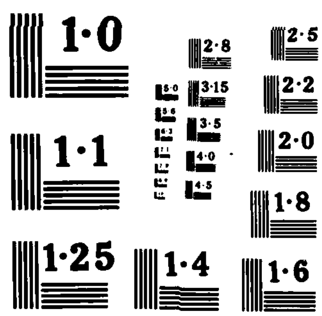
AD-A166 227 APPLICATIONS OF SATELLITE METEOROLOGY IN SUPPORT OF SPACE SHUTTLE(U) EASTERN SPACE AND MISSILE CENTER PATRICK AFB FL B B BOYD ET AL. DEC 85 ESMC-TR-85-07

1/1

UNCLASSIFIED F/G 4/2 NL

END
DATE FILMED
5-86
DTIC


1·0
2·8
2·5
3·15
2·2
1·1
3·5
2·0
4·0
4·5
1·8
1·25
1·4
1·6

ESMC-TR-85-07

APPLICATIONS OF SATELLITE METEOROLOGY IN SUPPORT OF SPACE SHUTTLE OPERATIONS

B.F. BOYD
T.M. MYERS, MAJOR USAF
Eastern Space and Missile Center
Patrick Air Force Base, Fla 32925

31 December 1985

FINAL REPORT

Approved for Public Release
Distribution Unlimited

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS NONE
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ESMC-TR-85-07	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Eastern Space and Missile Center 6b. OFFICE SYMBOL (If applicable) ESMC/WE	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State and ZIP Code) Patrick Air Force Base FLA 32925	7b. ADDRESS (City, State and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS. PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT NO.
11. TITLE (Include Security Classification) Applications of Satellite Meteorology in Support of Space Shuttle Operations.	
12. PERSONAL AUTHOR(S) Boyd, B. B.; Myers, T. M., and Funk, C. S.	
13a. TYPE OF REPORT Technical 13b. TIME COVERED FROM 1981 TO 1985	14. DATE OF REPORT (Yr., Mo., Day) 1985, December 15. PAGE COUNT 6
16. SUPPLEMENTARY NOTATION	
17. COSATI CODES FIELD / GROUP / SUB. GR.	18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Meteorology, Weather, Shuttle, Satellite, Interactive Graphics

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The paper presents a background on Shuttle operations and their sensitivities to weather. It lists an overview of weather impacts to the Shuttle operations 1981-1985. A brief summary of recent uses of the Meteorological Interactive Data Display System is presented with one specific mission (61A, 30 October 1985) described in detail.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☒ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL BILLIE F. BOYD	22b. TELEPHONE NUMBER (Include Area Code) 305-494-5915 22c. OFFICE SYMBOL ESMC/WER

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

SECURITY CLASSIFICATION OF THIS PAGE

INSTRUCTIONS FOR PREPARATION OF REPORT DOCUMENTATION PAGE

GENERAL INFORMATION

The accuracy and completeness of all information provided in the DD Form 1473, especially classification and distribution limitation markings, are the responsibility of the authoring or monitoring DoD activity.

Because the data input on this form will be what others will retrieve from DTIC's bibliographic data base or may determine how the document can be accessed by future users, care should be taken to have the form completed by knowledgeable personnel. For better communication and to facilitate more complete and accurate input from the origination of the form to those processing the data, space has been provided for the name, telephone number and office symbol of the DoD person responsible for the input cited on the form. These are to be noted in Block 22.

All information on the DD Form 1473 should be typed.

Only information appearing on or in the report, or applying specifically to the report in hand should be reported. If there is any doubt, the block should be left blank.

Some of the information on the forms *(e.g., title, abstract)* will be machine-indexed. The terminology used should describe th content of the report or identify it as precisely as possible for future identification and retrieval.

SPECIAL NOTE: UNCLASSIFIED ABSTRACTS AND TITLES DESCRIBING CLASSIFIED DOCUMENTS MAY APPEAR SEPARATELY FROM THE DOCUMENTS IN AN UNCLASSIFIED CONTEXT, E.G., IN DTIC ANNOUNCEMENT BULLETINS AND BIBLIOGRAPHIES OR OR BY ACCESS IN AN UNCLASSIFIED MODE TO THE RDT/E ON-LINE SYSTEM. THIS MUST BE CONSIDERED IN THE PREPARATION AND MARKING OF UNCLASSIFIED ABSTRACTS AND TITLES.

The Defense Technical Information Center *(DTIC)* is ready to offer assistance to anyone who needs and requests it. Call Data Base Input Division *(AUTOVON)* 284-7044; Com 202-274-7044.

SPECIFIC BLOCKS

SECURITY CLASSIFICATION OF THE FORM:

In accordance with DoD 5200.1-R, Information Security Program Regulation, Chapter V1 Section 2, paragraph 4-200, classification markings are to be stamped, printed, or written at the tops and bottom of the form in capital letters that are larger than those used in the text of the document. See also DoD 5220.22-M, Industrial Security Manual for Safeguarding Classified Information, Section II, paragraph 11a*(2)*. This form should be nonclassified, if possible.

Block 1.a. Report Security Classification: Designate the highest security classification of the report. *(See DoD 5200.00.1-R, Chapters, I, IV, VII, XI, Appendix A).*

Block 1.b. Enter the restricted marking or warning notice of the report *(e.g., CNWDI, RD, NATO).*

Block 2.a. Security Classification Authority: Enter the commonly used markings in accordance with DoD 5200.1-R, Chapter IV, Section 4, paragraph 4-400 and 4-402. Indicate classification authority.

Block 2.b. Declassification/Downgrading Schedule: Indicate specific date or event for declassification or the notation "Originating Agency Determination Required" or "OADR." Also insert *(when applicable)* downgrade to: ____________ on ____________, *(e.g., "Downgrade to Confidential on 6 July 1983). (See also DoD 5220.22-M, Industrial Security Manual for Safeguarding Classified Information, Appendix II).*

NOTE: Entry must be made in Blocks 2.a. and 2.b. except when the original report is unclassified and has never been upgraded.

Block 3. Distribution/Availability Statement of Report: Insert the statement as it appears on the report. If a limited distribution statement is used, the reason must be one of those given by DoD Directive 5200.20, Distribution Statements on Technical Documents. The Distribution Statement should provide for the broadest distribution possible within limits of security and controlling office limitations.

Block 4. Performing Organization Report Number*(s)*: Enter the unique alphanumeric report number*(s)* assigned by the organization originating or generating the report from its research and whose name appears in Block 6. These numbers should be in accordance with ANSI STD 239.23-74 "American National Standard Technical Report Number." If the Performing Organization is also the Monitoring Agency, enter the report number in Block 4.

Block 5. Monitoring Organization Report Number*(s)*: Enter the unique alphanumeric report number*(s)* assigned by the Monitoring Agency. This should be a number assigned by a Department of Defense or other government agency and should be in accordance with ANSI STD 239.23-74 "American National Standard Technical Report Number." If the Monitoring Agency is the same as the Performing Organization enter the report number in Block 4 and leave Block 5 blank.

Block 6.a. Performing Organization: For in-house reports, enter the name of the performing activity. For reports prepared under contract or grant, enter the contractor or the grantee who generated the report and identify the appropriate corporate division, school, laboratory, etc., of the author.

Block 6.b. Enter the office symbol of the performing organization.

Block 6.c. Enter the address of the performing organization, list city, state and ZIP code.

Block 7.a. Monitoring Organization — Name: This is the agency responsible for administering or monitoring a project, contract, or grant. If the monitor is also the performing organization, leave Block 7.a. blank. In the case of joint sponsorship, the monitoring organization is determined by advanced agreement. It can be either an office, a group, or a committee representing more than one activity, service or agency.

Block 7.b. Enter the address of the monitoring organization. Include city, state and ZIP code.

Block 8.a. Funding *(Sponsoring)* Organization — Name: Enter the full official name of the organization under whose immediate funding the document was generated, whether the work was one in-house or by contract. If the Monitoring Organization is the same as the Funding Organization, leave Block 8.a. blank.

Block 8.b. Enter the office symbol of the Funding *(Sponsoring)* Organization.

Block 8.c. Enter the address of the Funding *(Sponsoring)* Organization. Include city, state and ZIP code.

Block 9. Procurement Instrument Identification Number *(Contract, Grant, or other Funding Instrument)*: For a contractor or grantee report, enter the complete contract or grant number(s) under which the work was accomplished. Leave this block blank for in-house reports.

Block 10. Source of Funding *(Program Element, Project, Task Area, and Work Unit Number(s))*: These four data elements relate to the DoD budget structure and provide program and/or administrative identification of the source of support for the work being carried on. Enter the program element, project, task area, work unit number, or their equivalents that identify the principal source of funding for the work required. These codes may be obtained from the applicable DoD forms such as the DD Form 1498 *(Research and Technology Work Unit Summary)* or from the fund citation of the funding instrument. If this information is not available to the authoring activity, these blocks should be filled in by the responsible DoD Official designated in Block 22. If the report is funded from multiple sources, identify only the Program Element and the Project, Task Area and Work Unit Numbers of the principal contributor.

Block 11. Title and Its Security Classification: Enter the title in Block 11 in initial capital letters exactly as it appears on the report. Titles on all classified reports, whether classified or unclassified, must be immediately followed by the security classification of the title enclosed in parentheses. A report with a classified title should be provided with an unclassified version if it is possible to do so without changing the meaning or obscuring the contents of the report. Use specific, meaningful words that describe the content of the report so that when the title is machine-indexed, the words will contribute useful retrieval terms.

If the report is in a foreign language and the title is given in both English and a foreign language, list the foreign language title first, followed by the English title enclosed in parentheses. If part of the text is in English, list the English title first followed by the foreign language title enclosed in parentheses. If the title is given in more than one foreign language, use a title that reflects the language of the text. If both the text and titles are in a foreign language, the title should be translated, if possible, unless the title is also the name of a foreign periodical. Transliterations of often used foreign alphabets *(see Appendix A of MIL-STD-847B)* are available from DTIC in document AD-A080 800.

Block 12. Personal Author*(s)*: Give the complete name(s) of the author*(s)* in this order: last name, first name and middle name. In addition, list the affiliation of the authors if it differs from that of the performing organization.

List all authors. If the document is a compilation of papers, it may be more useful to list the authors with the titles of their papers as a contents note in the abstract in Block 19. If appropriate, the names of editors and compilers may be entered in this block.

Block 13.a. Type of Report: Indicate whether the report is summary, final, annual, progress, interim, etc.

Block 13.b. Period of Time Covered: Enter the inclusive dates *(year, month, day)* of the period covered, such as the life of a contract in a final contractor report.

Block 14. Date of Report: Enter the year, month, and day, or the year and the month the report was issued as shown on the cover.

Block 15. Page Count: Enter the total number of pages in the report that contain information, including cover, preface, table of contents, distribution lists, partial pages, etc. A chart in the body of the report is counted even if it is unnumbered.

Block 16. Supplementary Notation: Enter useful information about the report in hand, such as: "Prepared in cooperation with . . ." "Translation at *(or by)* . . ." "Symposium . . ." If there are report numbers for the report which are not noted elsewhere on the form *(such as internal series numbers or participating organization report numbers)* enter in this block.

Block 17. COSATI Codes: This block provides the subject coverage of the report for announcement and distribution purposes. The categories are to be taken from the "COSATI Subject Category List" *(DoD Modified)*, Oct 65, AD-624 000. A copy is available on request to any organization generating reports for the DoD. At least one entry is required as follows:

Field — to indicate subject coverage of report.
Group — to indicate greater subject specificity of information in the report.
Sub-Group — if specificity greater than that shown by Group is required, use further designation as the numbers after the period *(.)* in the Group breakdown. Use only the designation provided by AD-624 000.
Example: The subject "Solid Rocket Motors" is Field 21, Group 08, Subgroup 2 *page 32, AD-624 000)*.

Block 18. Subject Terms: These may be descriptors, keywords, posting terms, identifiers, open-ended terms, subject headings, acronyms, code words, or any words or phrases that identify the principal subjects covered in the report, that conform to standard terminology and exact enough to be used as subject index entries. Certain acronyms or "buzz words" may be used if they are recognized by specialists in the field and have a potential for becoming accepted terms. "Laser" and "Reverse Osmosis" were once such terms.

APPLICATIONS OF SATELLITE METEOROLOGY IN SUPPORT OF SPACE SHUTTLE OPERATIONS

B. F. Boyd, T. M. Myers, and C. S. Funk

Office of the Staff Meteorologist
Eastern Space and Missile Center
Patrick Air Force Base, Florida

1. INTRODUCTION

The United States Air Force (USAF) Air Weather Service's Detachment 11 of the 2nd Weather Squadron is tasked to provide meteorological and environmental support to the USAF Eastern Space and Missile Center (ESMC), the National Aeronautics and Space Administration's (NASA) Kennedy Space Center (KSC), and the Department of Defense (DOD) Manager for Space Shuttle Support Operations. They provide weather support to the Cape Canaveral Air Force Station (CCAFS), Patrick Air Force Base (PAFB), KSC, and the entire Eastern Test Range (ETR); primarily through the Cape Canaveral Forecast Facility (CCFF). The CCFF is a 24-hour-a-day forecasting and observing operation. As part of its normal support, it provides specialized forecasts for all missile and space launches from the ETR/KSC and weather services for recovery forces. By far, the launch, landing, and ground operations of the Space Shuttle require the most precise weather support. Most aspects of Space Shuttle operations are sensitive to one or more meteorological parameters. As the Shuttle proved itself in its early missions ~~(Table 1)~~ and became operational with a significant increase in the number of scheduled missions ~~(Table 2)~~, it was evident that weather and weather support would become critical elements in achieving and maintaining the higher launch rate.

TABLE 1

SHUTTLES LAUNCHED BY YEAR

YEAR	TOTAL LAUNCHED
1981	2
1982	3
1983	4
1984	5
1985	9

TABLE 2

PROJECTED SHUTTLE LAUNCHES BY YEAR

YEAR	TOTAL LAUNCHES
1986	17
1987	23
1988	24

To deal with this problem, NASA and the USAF, at the local level, formed a joint Meteorological Systems Modernization Program (MSMP). This group is co-chaired by the Technology Projects Office of the KSC and the Office of the Staff Meteorologist of the ESMC. Through the efforts of the MSMP, and joint funding by the Air Force and NASA, several improvements in meteorological systems were accomplished, allowing better utilization of satellite data. The key improvement was the Meteorological Interactive Data Display System (MIDDS).

2. THE METEOROLOGICAL INTERACTIVE DATA DISPLAY SYSTEM (MIDDS)

To assist the forecaster with the problems of integrating data from various sources and producing mission support products which use all of the available data in an internally consistent manner, the MIDDS was developed under contract with the Space and Science Engineering Center (SSEC). The MIDDS (Young, 1985) consists of an IBM 4341 computer with appropriate peripherals and workstations in supporting a variation of the Man Computer Interactive Data Access System (McIDAS) software (Suomi, 1983). The system provides integration of the data sources available to the CCFF into a single data base where the various types of data can be melded and displayed together for forecaster use. It also provides growth for new data sources and allows for a significant increase in the applications which the forecasters and system users are expected to make after they become more familiar with the power of the system. Utilization of the MIDDS over an eighteen month period has been presented previously by Kolczynski, Myers, and Boyd (1985,

1986, 1986). To better understand weather impacts to the Shuttle, one must look at Shuttle operations and weather constraints.

3. SHUTTLE OPERATIONS

There are many aspects to Shuttle operations that are much more susceptible to weather than the casual observer might realize.

3.1 Launch and Landing.

The relative low frequency of flight might lead one to think the most optimal times for launch as related to weather are easily attained. Just the opposite is true. Actual launch times are rigidly controlled by the orbital mechanics of the particular payloads and to some extent with other orbiting vehicles. In the extreme case, mission 51-G had only a four minute launch window. Although most missions are not that restrictive, all have fairly limited launch periods. Within those limited launch windows there may be a much smaller optimal launch period. Once launch is accomplished, Return To Launch Site (RTLS) and Transalantic Abort (TAL) landings are also fixed. Abort Once Around (AOA) and normal End of Mission (EOM) are somewhat more flexiable, but those opportunities are also very restrictive at any given site, with normally not more than two opportunities per day. For a launch to be completed, weather for a RTLS must also be acceptable. The climatological chances for a successful launch vary at the ETR by time of day and month as illustrated by Figures 1 and 2.

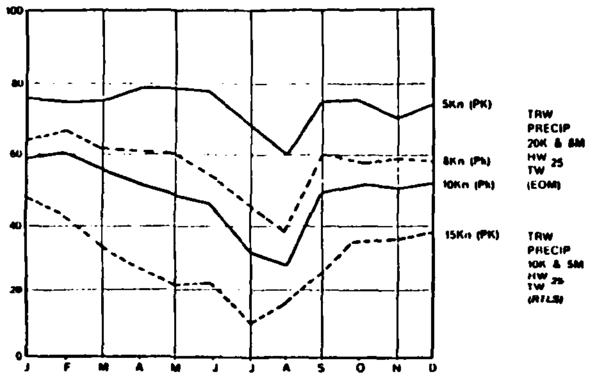


Fig. 1. Percent Probability No Go All Parameters 0800L.

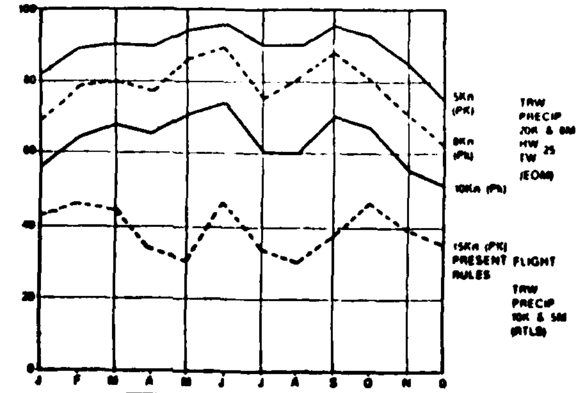


Fig. 2. Percent Probability No Go all Parameters 1400L

3.2 Prelaunch Processing.

Although launch and landings are the most visable Shuttle operations, there is much to be accomplished between flights. When a payload is returned from outer space aboard the orbiter, the vehicle is towed back along the tow road to one of the Orbiter Processing Facilities (OPFs). In the OPF the payloads are removed, the payload bay is reconfigured for the next mission, broken tiles are repaired, brakes are fixed, etc. Once the orbiter is ready,, it is towed to the Vehilce Assembly Building (VAB) where it is put in an upright position and stacked on top of the Mobile Launch Platform where it is mated with the Solid Rocket Boosters (SRBs) and the External Tank (ET). Once this process is complete the entire Mobile Launch Platform is transported along the crawlerway 4.1 miles to Launch Complex 39A, typically a 6 to 8 hour trip during which the vehicle is vulnerable to weather. The Mobile Launch Platform, along with the vehicle, is left on the pad after the crawler pulls out from underneath it. The vehicle is launched from the Mobile Launch Platform. Any loss of production during this processing cycle may well impact launches when the number of processing days are condensed due to more frequent launches. The single largest loss of processing time is due to thunderstorms. Loss of production time due to lightning occurrences has been a problem since the origin of the space program at the ETR. (Gibbons, et al, 1985)

4. SHUTTLE WEATHER CONSTRAINTS

As shown in Table 3, weather impacts nearly all facets of Shuttle operations from rollover and rollout to final recovery of the Shuttle at end of mission. This table clearly illustrates the sensitivity of Shuttle operations to the environment and the subsequent impact of forecast support in maintaining Shuttle launch schedules.

TABLE 3

STS WEATHER SENSITIVITIES

Temperature, Winds, Precipitation

Temperature less than 31°F or greater than 99°F.

Precipitation forecast or occurring from the start of external tank loading through launch.

Ice accumulation greater than 1/16 inch on the external tank.

Surface winds (measured at 60 feet above natural grade) greater than 34.4 knots (peak) or 22.6 knots (steady state) from all azimuths (lift off).

Prelaunch surface winds greater than 49 knots steady state while on the pad.

Upper air wind shears outside vehicle load limits.

Flightpath (Nominal or RTLS)
Severe Weather Constraints
(to protect the vehicle from lightning strikes)

Cannot be within 2NM above or 5NM horizontal distance of the anvil associated with a thunderstorm.

Cannot be through any cloud (convective or layered) from which precipitation (including virga) is observed.

Cannot be through clouds in the dissipating stage which have detected lightning by the electric field mill network within 15 minutes prior to launch.

Cannot be through any cloud if a 1000 volt per meter or greater ground level electric field contour encompasses launch (or landing) site.

Offshore Crew Recovery Area Constraints
(from launch pad to 50NM in the Atlantic)

Surface wind greater than 25 knots.

Ceiling less than 500 feet.

Visibility less than 0.5NM.

Seas greater than 8 feet.

Solid Rocket Booster (SRB)
Recovery Area Constraints

Sea state greater than sea state code 3 (3-5 foot moderate waves).

Visibility less than 1.5NM.

Landing Constraints
(Return to Launch Site and End of Mission)

Ceiling less than 10,000 feet (8,000 feet if Microwave Landing System (MLS) available).

Visibility less than 7 miles (5 miles if MLS). Final launch decision relies on slant range evaluation by weather reconnaissance flights along the return to launch site path at KSC and reentry profile at Edwards AFB or White Sands.

Surface wind component (including max gusts) greater than 25 knots headwind, 20 knots crosswind (lakebed), 15 knots crosswind (runway), 10 knots crosswind (EOM), or 10 knots tailwind.

Any precipitation (RTLS), or precipitation within 50NM (EOM at KSC).

Turbulence greater than light to moderate.

Range Safety Constraints

The ESMC Office of Range Safety also has restrictions under the following weather conditions, due to tracking and blast damage considerations:

Ceiling less than 1,600 feet.

Visibility less than 5 miles.

Blast due to destruct sequence resulting in predicted fatality probability values greater than one per-hundred thousand will result in hold or scrub.

Shuttle Ferry Flight
(Edwards AFB to KSC)

If the Shuttle lands at Edwards AFB instead of the Kennedy Space Center, the following weather constraints apply to the return flight of the NASA B-747 Shuttle Carrier Aircraft:

Flight conducted daylight hours only.

No flight through visible moisture.

Flight level temperature must be greater than 15°F.

No turbulence greater than moderate.

Crosswinds must be less than 15 knots for takeoff and landing.

Take off runway ambient air temperture must be less than 92°F.

5. A CASE STUDY

Weather has impacted the Shuttle in various ways over the history of the program. A general overview is contained in Table 4.

TABLE 4

WEATHER IMPACT
(THROUGH DEC 85)

MISSION	IMPACT
STS-3	EOM diverted to WSSH and delayed 1 day (Mar 82)
STS-7	EOM diverted to Edwards vice KSC (Jun 83)
STS-8	Launch delayed 17 minutes by thundershowers (Aug 83)
41-C	EOM diverted to Edwards due to KSC weather (Apr 84)
41-D	SCA flight delayed 1 day due to tropical storm Diana (Aug 84)
51-A	Launch delayed 1 day by windshears (Nov 84)
51-C	Delayed due to cold temperature impacts on ET fueling (Jan 85)
51-D	Held to end of launch window by clouds and showers (Apr 85)
51-D	Landing delayed 1 orbit due to showers. Landed with maximum crosswind at KSC (Apr 85)
SCA	Orbiter Columbia TPS damaged by precipitation during transit to KSC

51-I Launch delayed 1 day by electrically active convective clouds (Aug 85)

61-C Weather (clouds) hold to near end of window, then aborted due to vehicle problem (Dec 85)

5.1. Mission 61A Background.

A recent case where the use of satellite data via the MIDDS prevented a weather impact was mission 61A, 30 October 1985. Tropical Storm Juan had dominated the weather along the Gulf states and Florida for several days prior to launch, requiring a detailed metwatch during prelaunch processing as well as the launch itself. In the 48 hours prior to launch a number of operations occurred which are weather sensitive such as: loading of the external tank, last minute payload work, and work along the exposed service structures. Forecasters at the Cape Canaveral Forecast Facility (CCFF), using the MIDDS looping capability of GOES imagery and incorporating wind tower and lightning detection data were able to minimize the impact of the transient squall line feeder bands of Tropical Storm Juan resulting in a nominal launch countdown. Figures 3 thru 6 show daily accumulated rainfall for the southeast, and the eastward movement along the Gulf coast of the rainfall maximum through 30 October (NOAA, 1985). Figures 7 and 8 show the 1200 GMT position of Juan on 30 October.

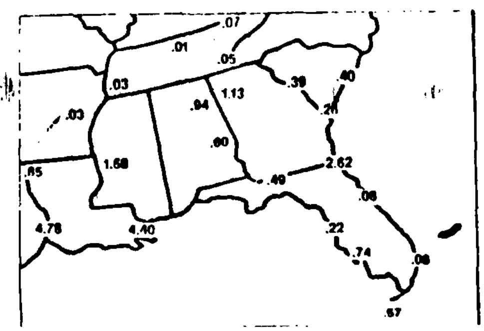


Fig. 3. 24 Hour Precipitation Totals for 28 Oct 85.

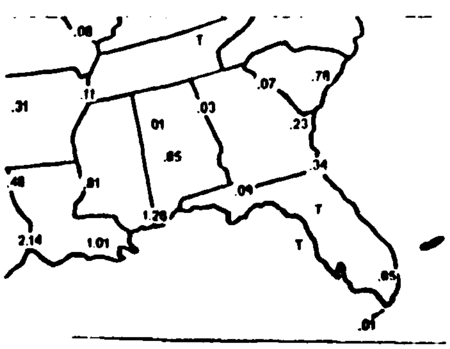


Fig. 4. 24 Hour Precipitation Totals for 29 Oct 85.

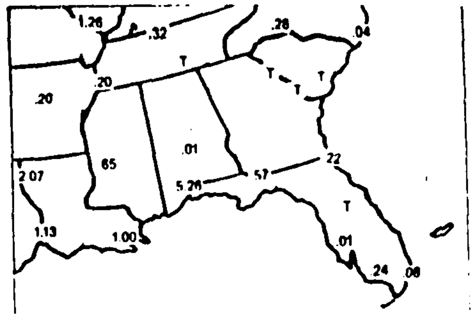


Fig. 5. 24 Hour Precipitation Totals for 30 Oct 85.

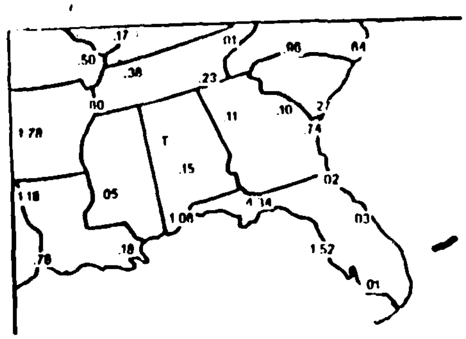


Fig. 6. 24 Hour Precipitation Totals for 31 Oct 85.

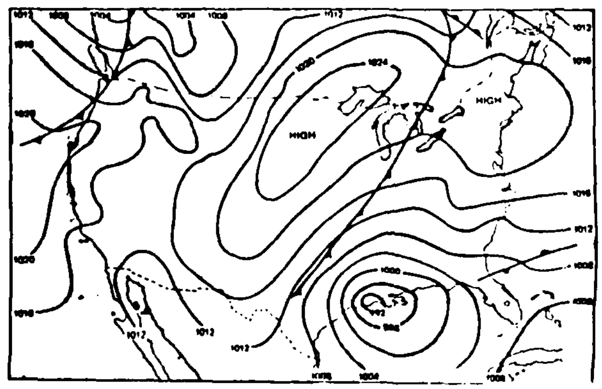


Fig. 7. Surface Weather Map at 0700 EST, 30 Oct 85.

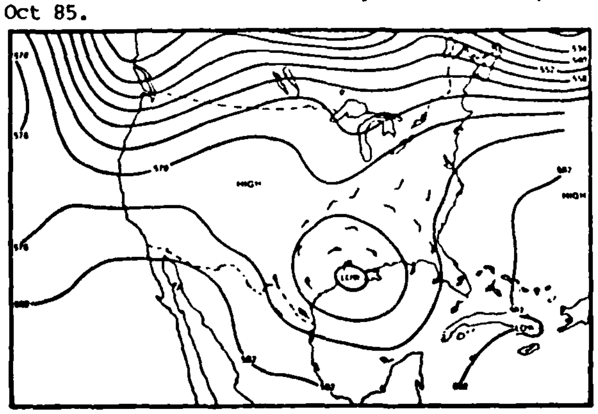


Fig. 8. 500-Millibar Height Contours at 7:00 A.M., 30 Oct 85.

5.2. Mission 61A Weather Support.

At the launch minus 24 (-24) hours briefing, through utilization of the MIDDS graphic analysis and image looping, the Shuttle Weather Officer (SWO) was able to assure the launch control officials that the only direct impact of Tropical Storm Juan would be in the form of the squall line feeder bands. On launch day, the local weather situation was further complicated by a weak frontal boundary approaching north Florida and forecast temperatures in excess of 80°F contributing to the already unstable environment. At launch -8 hours the launch director was briefed of the posibility of intermittnet rainshowers and thunderstorms during the launch window (1700-2000 GMT). Looking at the most current near realtime satellite imagery on the closed circuit television system and forecast guidance by the Shuttle weather forecasters, the lauch director made the decision to load the external tanks and begin final preparations for launch. As the launch countdown progressed a squall line in the Gulf of Mexico off the west coast of Florida presented an area of particular concern. After sunrise, clear skies over most of central Florida allowed rapid warming of the land surface and the convective process began. By 1600 GMT (11 AM EST) the squall line was along the west coast of Florida (see Figure 9 for clouds as depicted by the MIDDS).

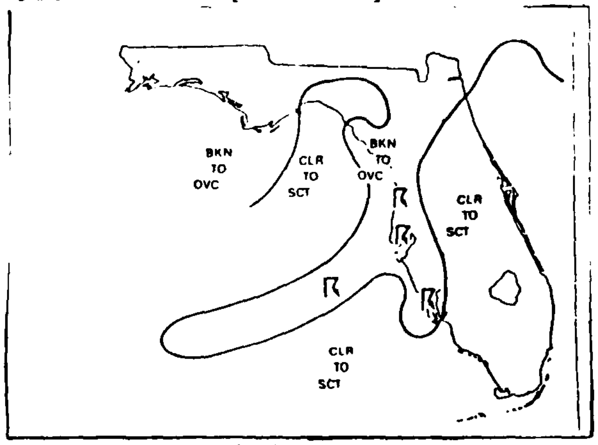


Fig. 9. Cloud Depiction 16Z, 30 Oct 85.

Numerous thundershowers and rainshowers accompained the feeder band. Cumulus and towering cumulus were developing throughout east Florida and the launch area. At launch -45 minutes, a conference was held between the launch director, flight director, mission management team, and the SWO at the CCFF for launch weather and the Spaceflight Meteorology Group in Houston for TAL and AOA weather. The SWO, using the available GOES rapid scan data, displayed the developing thunderstorm pattern and cumulus fields. He discussed the threat of thunderstorm development along outflow boundaries in the unstable local environment and suggested a Go as early in the launch window as possible. As the 1700 GMT opening of the launch window approached, so did the thunderstorms. At 1700 GMT on 30 October, (Figure 10), STS 61-A was launched successfully from pad 39A at the Kennedy Space Center. According to the official NASA release, despite a tropical storm threatening the Gulf coast states and Florida for several days, the "countdown was uneventful and ascent to orbit normal".

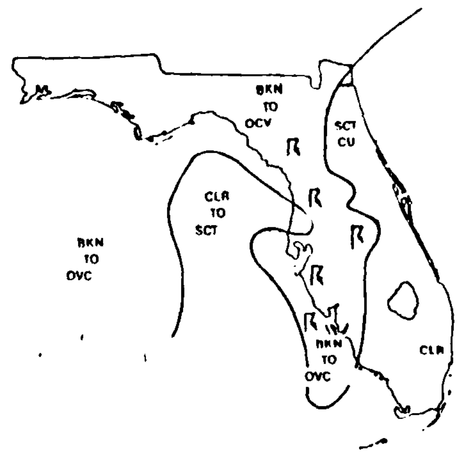


Fig. 10. Cloud Depiction 17Z, 30 Oct 85.

6. SUMMARY

This paper has presented a background to Shuttle operations and their sensitivities to the weather. A brief overview of weather impacts was presented to establish the impacts, and one specific mission application used as an illustration of typical satellite applications to Shuttle missions. The MIDDS and its readily available satellite data are key elements of weather support essential to the successful Shuttle operations.

7. REFERENCES

Boyd, B. F., J. E. Erickson, and T. M. Myers, (1985): Modernization of Weather Support to the Space Transportation System, Preprints Second International Conference on the Aviation Weather Systems, Montreal, Amer. Meteor. Soc., 233-237.

Boyd, B. F. and T. M. Myers, (1986): Interactive Information and Processing Systems Used For Meteorological Support to the Eastern Test Range (to be presented at the Second International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, Miami, FL 13-17 Jan 86).

Court, A. and J. F. Griffiths, (1982): "Thunderstorms: A Social, Scientific, and Technological Documentation", Vol 2, Thunderstorm Morphology and Dynamics, E. Kessler, Ed. NOAA/ERL

Gibbons, W. C., B. F. Boyd, and W. Jafferies, (1986): Lightning at Kennedy Space Center (to be presented at the AIAA 24th Aerospace Sciences Meeting, Reno, NV, 6-8 Jan 86).

Kolczynski, E. F., T. M. Myers, and B. F. Boyd (1986): Meteorological Range Support Requirements and Implications for the Future of Shuttle Operations (to be presented at the AIAA 24th Aerospace Sciences Meeting, Reno, NV, 6-8 Jan 86).

Myers, T. M., and B. F. Boyd, (1985): Status Report on the Applications of the Meteorological Interactive Data Display System to Space Shuttle and Range Support at the Kennedy Space Center and Cape Canaveral AFS, Preprints Conference on Aerospace and Range Meteorology, Huntsville, AL, Amer. Meteor. Soc., 73-80.

NOAA, (1985): "Daily Weather Maps, Weekly Series, October 28-November 3, 1985", National Meteorological Center, National Weather Service.

Suomi, V. E., R. Fox, S. S. Limage, and W. L. Smith, (1983): McIDAS III: A Modern Interactive Data Access and Analysis System, J. of Climate and Appl. Meteor., 22, 766-778.

Young, J. T., C. Norton, R. Uram, R. Oehlken, R. Fox, D. Wade, T. Whittaker, J. Benson, and J. Rueden, (1985): The Meteorological Interactive Data Display System, Preprints Second International Conference on the Aviation Weather System, Montreal, Amer. Meteor. Soc., 334-339.

END

DATE
FILMED
5-86

DTIC